NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

MATERIALS AND RESEARCH DIVISION

Experimental Study ND 91-04

Evaluation of Silane and Various Hot Bituminous Overlay Thicknesses

Final Report

Project IR-094-6(064)193

July 1997

prepared by

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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT	EXPERIMENTAL PROJECT NO. [1] STATE YEAR NUMBER SUF.: ND 91 - 04	CONSTRUCTION PROJ. NO. [8]: IM-1-094(064)193	LOCATION [28]: Burleigh County
	EVALUATION FUNDING [48]: 1 [X] HP&R; 2 [ ] CONSTRUCTION; 3 [ ] DEMONSTRATION; 4 [ ] IMPLEMENTATION	NEEP NO. [49]:	PROPRIETARY FEATURE? [51]: [X] YES [ ] NO
SHORT TITLE	TITLE [52]: Evaluation of Silane and Hot Bituminous Overlay as a Treatment for "D" Cracking on Portland Cement Concrete		
THIS FORM	DATE [140] MO. YR.: 07-97	REPORTING [144]: 1 [ ] INITIAL; 2 [ ] ANNUAL; 3 [X] FINAL	
KEY WORDS	KEY WORD 1 [145]: MAINTENANCE	KEY WORD 2 [167]: PAVEMENT	
	KEY WORD 3 [189]: OVERLAYS	KEY WORD 4 [211]:	
	UNIQUE WORD [233]: Concrete Treatment	PROPRIETARY FEATURE NAME [255]: Silane	
CHRONOLOGY	Date Work Plan Approved [277]: MO. 02 - YR. 92; Date Feature Constructed [281]: 05-92	Evaluation Scheduled Until [285]: 05-97; Evaluation Extended Until [289]:	Date Evaluation Terminated [293]: 05-97
QUANTITY AND COST	QUANTITY OF UNITS (Rounded to whole numbers) [297]: 25,494	UNITS [305]: 1 [ ] LIN. FT.; 2 [X] S.Y.; 3 [ ] S.Y.-IN.; 4 [ ] C.Y.; 5 [ ] TON; 6 [ ] LBS.; 7 [ ] EACH; 8 [ ] LUMP SUM	UNIT COST (Dollars, Cents) [306]: 3.28
AVAILABLE EVALUATION REPORTS	[315] [X] CONSTRUCTION	[X] PERFORMANCE	[X] FINAL
EVALUATION	CONSTRUCTION PROBLEMS [318]: 1 [X] NONE; 2 [ ] SLIGHT; 3 [ ] MODERATE; 4 [ ] SIGNIFICANT; 5 [ ] SEVERE	PERFORMANCE [319]: 1 [ ] EXCELLENT; 2 [ ] GOOD; 3 [X] SATISFACTORY; 4 [ ] MARGINAL; 5 [ ] UNSATISFACTORY	
APPLICATION	[320] 1 [ ] ADOPTED AS PRIMARY STD.; 2 [ ] PERMITTED ALTERNATIVE; 3 [ ] ADOPTED CONDITIONALLY	4 [ ] PENDING; 5 [ ] REJECTED; 6 [ ] NOT CONSTRUCTED	*(Explain in Remarks if 3, 4, 5, or 6 is checked)*
REMARKS	[321] Full length transverse cracks decrease as hot bituminous pavement thicknesses increase. Silane section appears to be performing slightly better than the corresponding control section in slowing the progression of "D" cracking. It is recommended that hot bituminous pavement be used to give structural integrity to CRCP that is in the early stages of "D" cracking. The use of silane as a retardant in the progression of "D" cracking is questionable and is not recommended for use on North Dakota projects. [700]		

FORM FHWA 1461 (REV. 8-79)   Previous Editions are Obsolete

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July, 1997

Written by
Curt Dunn

Disclaimer

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EVALUATION OF SILANE AND HOT BITUMINOUS OVERLAY AS A TREATMENT FOR "D" CRACKING ON PORTLAND CEMENT CONCRETE

Objective

"D" cracking is a freeze-thaw deterioration of concrete pavements observed in some pavements after three or more years of service. "D" cracks are closely spaced crack formations parallel to transverse and longitudinal joints that later multiply outward from the joints toward the center of the pavement panel.

"D" cracking varies with the pore properties of certain types of aggregate particles and the environment in which the pavement is placed. Due to the natural accumulation of water under pavements in the base and subbase structures, the aggregate may eventually become saturated. When aggregates are exposed to freeze and thaw cycles, cracking of the concrete starts in the saturated aggregate.

The problem of "D" cracking may be reduced by preventative measures such as selecting aggregates that act better in freeze-thaw cycles, reducing the maximum particle size where marginal aggregates must be used, and installing an effective drainage facility for carrying free water from the pavement subbase. Once "D" cracking has been observed in the pavement surface there are limited alternatives to treat and control its progress.

The objective of this experimental project is to evaluate and compare the effect silane and various hot bituminous overlay thicknesses will have on slowing "D" cracking on a Portland Cement Concrete (PCC) pavement surface.

Silane surface treatment

Silane is a clear, penetrating, water-based alkylalkoxysilane sealer. The silane solution is a white milky liquid.

The purpose of applying silane is to protect the PCC surface from surface moisture entering through open cracks and pores. It is hoped silane will penetrate at least 1/4" into the PCC. Placing the silane sealer on the concrete surface may slow or reduce the continued progress of "D" cracking.

Hot bituminous overlays

Hot bituminous overlays, like silane, may also serve as a sealer for the concrete surface. Reaching an optimum thickness of HBP may not only aid in slowing down the progression of "D" cracking, but may also benefit the existing roadway structurally.

Scope

In 1992, The North Dakota Department of Transportation (NDDOT) implemented an experimental project designed to study the above objectives. Test sections consisting of applications of silane and various overlay thicknesses of HBP were constructed on select North Dakota roadways. These roadways were limited to surfaces composed of PCC that had also been suffering from "D" cracking.

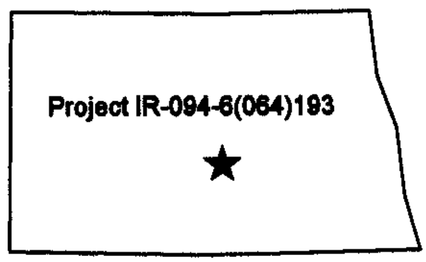
Evaluations will be made annually to determine how effective silane and the various HBP thicknesses are in stopping the advancement of "D" cracking.

Evaluations on the HBP sections will include items such as crack counts as well as rut and ride performance. Evaluations made on the silane section will include monitoring the difference in progression, if any, between that section and the corresponding control section. The HBP and silane test sections will be monitored for five years.

LOCATION

The HBP and silane test sections are located on Interstate 94 between the Burleigh-Kidder County line east to Dawson. A detail map of the these sections is included in appendix A.

The project limits are from reference marker 195 to 198 in the eastbound direction. In the westbound direction, the project limits are from reference marker 201 to 208.



Project History

Construction

Table 1 shows the history of the pavement section on Interstate 94 from mile 196 to mile 198 (EB).

Year Constructed	Type of Construction	Depth (in.)	Rdwy Width (ft.)
1966	Grade		48
1966	Aggregate Base	3.0	27
1966	Cont. - Reinf. P.C.C.	7.0	24
1966	Aggregate Base Shoulders	3.7	20
1966	Plant Mix Base Shoulders 120-150	2.0	18
1966	Hot Bit Pavement Shoulders	3.0	13
1981	Contract Chip Seal Shoulders MC-3000		13
1983	Concrete Pavement Repair		
1985	Maintenance Seal Shoulders		10
1987	Maintenance Gravel Seal MC-3000		10
1988	Concrete Pavement Repair		
1992	Hot Bit Pavement (Class 33) 120-150	4.0	24
1992	Inside Shoulder	3.8	3
1992	Outside Shoulder	3.0	10
1995	Contract Chip Seal CRS-2LM		24

Table 1

Table 2 shows the history of the pavement section on Interstate 94 from mile 202 to mile 208 (WB).

Year Constructed	Type of Construction	Depth (in.)	Rdwy Width (ft.)
1965	Grade		48
1966	Aggregate Base	3.0	27
1966	Cont. - Reinf. P.C.C.	7.0	24
1966	Aggregate Base Shoulders	3.7	20
1966	Plant Mix Base Shoulders 120-150	2.0	18
1966	Hot Bit Pav't Shoulders	3.0	13
1981	Contract Chip Seal MC-3000		13
1983	Concrete Pavement Repair		
1987	Maintenance Gravel Seal MC-3000		10
1988	Concrete Pavement Repair		
1992	Hot Bit Pavement (Class 33) 120-150	4.0	24
1992	Inside Shoulder	3.8	3
1992	Outside Shoulder	3.0	10
1995	Contract Chip Seal CRS-2LM		24
MP 202 to 203 = Silane Treatment 1992 MP 203 to 205 = HBP 4.0" 1992 MP 205 to 206 = HBP 3.0" 1992 MP 206 to 207 = HBP 2.5" 1992 MP 207 to 208 = HBP 2.0" 1992			

Table 2

Traffic

Table 3 depicts the one-way traffic estimates between the Long Lake Interchange and the Steele Interchange (EB).

Year	Pass>Car	Trucks	Total	Max Hour	Flex ESAL
1991	1,950	420	2,370	280	340
1997	2,455	520	2,975	300	423

Table 3

Table 4 depicts the one-way traffic estimates between the Steele Interchange and the Dawson Interchange (WB).

Year	Pass>Car	Trucks	Total	Max Hour	Flex ESAL
1991	1,930	420	2,350	280	340
1997	2,435	540	2,975	300	438

Table 4

Design

The experimental project was designed with the intent to determine which of the two treatments, an AC overlay or silane, will best slow the progress of "D" cracking.

The original design called for five test sections containing various HBP overlay thicknesses and two silane test sections.

The silane sections were designed with control sections adjacent to them for comparison purposes. The HBP sections were designed to include sections containing thicknesses of 2", 2.5", 3" and 4". The plans required section 2, the 4" section, to be paver-laid in two approximately equal lifts and the other sections paver-laid in one lift.

In 1995 one of the silane sections (EB) and its corresponding control section were overlaid with 2.5" of Class 33 HBP. Table 5 on the following page shows a detailed listing of treatment and control locations for the remaining sections.

Section	Treatment	Direction	Mile Point
2b	4" Overlay	East Bound	196 to 198
2a	4" Overlay	West Bound	203 to 205
3	3" Overlay	West Bound	205 to 206
4	2.5" Overlay	West Bound	206 to 207
5	2" Overlay	West Bound	207 to 208
1	Silane	West Bound	202 to 203
	Control	West Bound	201 to 202

Table 5

The specified mix design was a Class 33 aggregate with a 6.8%,120-150 asphalt. A copy of North Dakota's special provision for silane is in appendix B.

Construction

The general contractor was Anderson Brothers Construction based in Brainerd, Minnesota. Milling operations were done by Industrial Builders, from Fargo, North Dakota. The contractor for the silane application was Traffic Safety Service Incorporated out of Fargo, North Dakota. The surface cleaning contractor was Humble Equipment Company from Ruston, Louisiana.

The first overlay operation began with section 2 on April 27, 1992. The first 2" lift in section 2 failed compaction. These problems were corrected as the project progressed. After completing section 2, eastbound, the contractor continued operations on the westbound section 2 from station 522+11.8 to 627+71.8.

The contractor laid the first 2" lift in section 2 then moved onto section 5. Section 5 is a 2" overlay and extends from station 733+31.8 to 786+11.8 westbound.

When section 5 was completed, the contractor finished section 4 then proceeded onto section 3.

The average field density was 146.5 lbs/cu.ft and densities were running in the

97-98% range.

The engineer commented that Anderson Brothers was well organized and achieved quality work.

The silane operation began on May 18, 1992. The weather was windy and warm. Before the silane was applied the surface was cleaned. This was accomplished with the use of a shotblast machine called a "Skidabrader". The Skidabrader removed all debris, painted markings, oil, grease, chemical films, and other deleterious material.

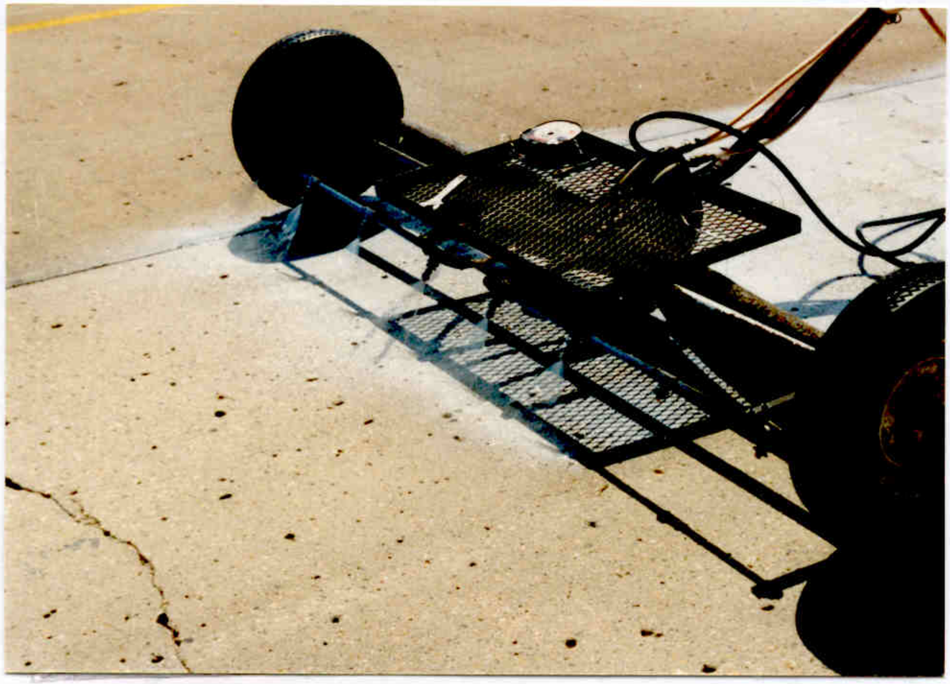


Photo 1. Overview of the silane application on I-94.

The same contractor that applied the silane south of Fargo also applied silane on this project. The contractor had improved on their application methods used on the project south of Fargo. The pressure had been increased and a carpet was used around the parameter of the spray nozzles to improve the application (photo 1).

After application, the silane took approximately five to ten hours to completely dry. If an alcohol based silane rather than a water based silane were used, operations may have been suspended because of the windy conditions encountered that day. Alcohol based silane may have evaporated too rapidly and the silane would not have had time to cure properly. The overlay operation, shotblasting operation and silane application went well.

Evaluation

Materials and Research conducted the evaluation on May 15, 1997. The sections located in the westbound lane of I-94 were inspected first. Starting with section 5, the evaluation progressed westward through the various HBP overlay test sections, including the silane test section. Upon completing the westbound test sections, an inspection was conducted on the eastbound 4" overlay test section.

The following evaluation is divided into subtitles, each covering a different section of roadway. Total full length crack counts were taken of each HBP overlay test section. Only transverse cracks that extended from three-quarter to all the way across the roadway were designated as full length cracks. Any transverse cracks shorter than this were not counted.

Rut and Ride data was also gathered for all of the HBP test sections. Table 6, tabulates the 1997 rut and ride results obtained from PaveTech for the various overlay HBP thicknesses . These results depict the average rut and ride scores per mile.

The PaveTech data given reflects a slight improvement in ride scores from the previous data. This is mostly due to the acquirement of new testing equipment by the department. The new testing equipment involves the use of laser which in turn minimizes the effect of wind, noise, water, and the texture of the road surface.

Overlay Thickness	Direction	From Mi. Pt.	To Mi. Pt.	Avg. Rut	Ride
4 Inch	East	196	197	0.19	4.37
4 Inch	East	197	198	0.19	4.43
2 Inch	West	208	207	0.10	4.10
2.5 Inch	West	207	206	0.09	4.34
3 Inch	West	206	205	0.06	4.20
4 Inch	West	205	204	0.07	4.24
4 Inch	West	204	203	0.07	4.31

Table 6

The Pave Tech distress rut and ride scores are rated according to the following scale.

	Rut Rating (inch)	Ride Rating
Excellent	0.004 - 0.10	> 4.00
Good	0.10 - 0.25	3.50 - 4.00
Fair	0.25 - 0.50	3.00 - 3.49
Poor	0.50 >	< 3.00

Materials and Research conducted a ride inspection over all of the HBP test sections. The ride inspection was taken at a speed of approximately 65 mph. Results of the ride inspection yielded generally a good ride with isolated areas where the ride appeared choppy. There were no significant differences in ride between any of the HBP test sections.

Westbound 2" HBP Overlay (Section 5)

Photo 2 depicts a typical transverse crack in this test section. Total full length transverse cracks registered in a 1500' stretch of roadway is approximately 227. Most of the cracks appear to be tight. No noticeable rutting was present. The general surface appearance of the 2" HBP overlay as well as the with the 21/2", 3", & 4" HBP overlays is due to a chip seal placed in 1995 that has partially failed.

Photo 2. View of a typical crack in the 2" overlay test section.

Westbound 2 1/2" HBP Overlay (Section 4)

Photo 3 depicts a typical transverse crack in this test section. Total full length transverse cracks registered in a 1500' stretch of roadway is approximately 185. In the fourth annual report the number of cracks reported were 207, however, upon further examination of the notes a figure of 169 was more accurate. A total of approximately 16 more transverse cracks have progressed to three-quarters or more of full length since the last evaluation. Most of the cracks appear to be tight. There does not appear to be any noticeable rutting.

Photo 3. A typical transverse crack located in the 2 1/2" overlay test section.

Westbound 3" HBP Overlay (Section 3)

Photo 4 depicts a typical crack in this test section. Total full length transverse cracks registered in a 1500' stretch of roadway is approximately 169. Most of the cracks appear to be tight. There does not appear to be any noticeable rutting.

Photo 4. View of a typical transverse crack in the 3" overlay test section.

Westbound 4" HBP Overlay (Section 2a)

Photo 5 depicts a typical crack in this test section. Total full length transverse cracks registered in a 1500' stretch of roadway is approximately 90. Many of the crack widths look slightly wider than the other sections. There does not appear to be any noticeable rutting.

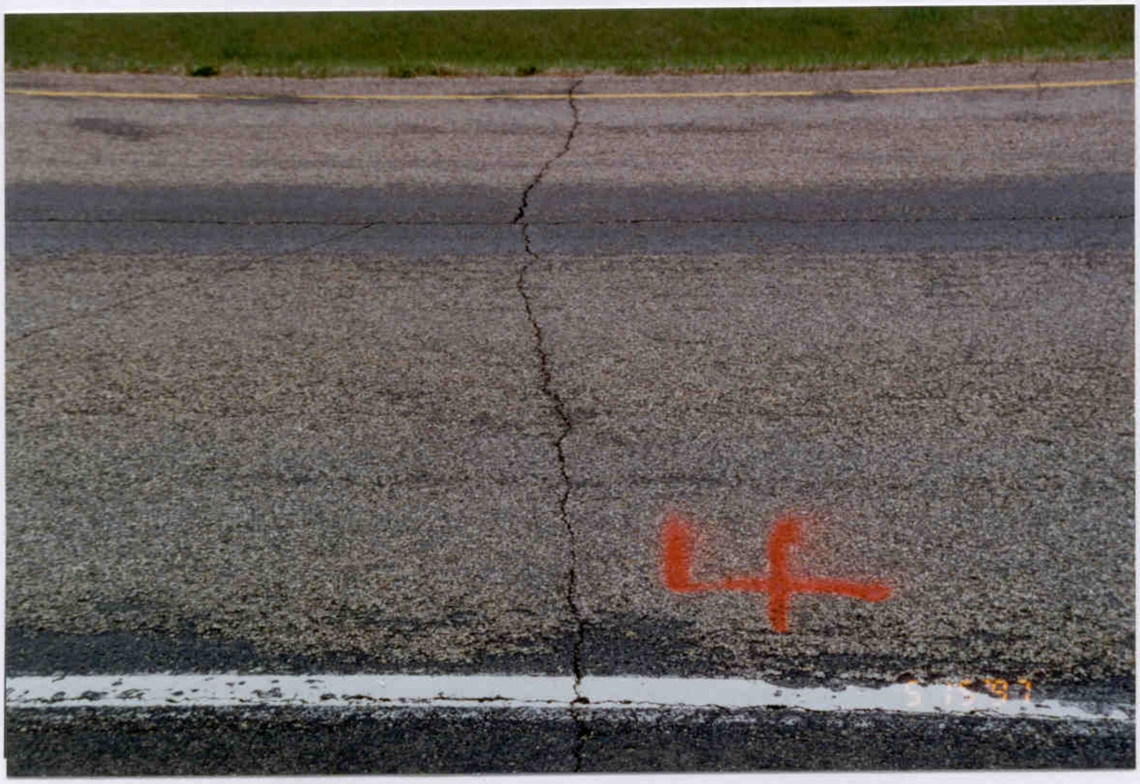


Photo 5. Typical transverse crack in the 4" overlay test section (WB).

Silane Test Section & The Corresponding Control Section (Section 1)

Photo 6 shows a view of a typical section of roadway located in the silane test section.

Photo 6. Overview of typical cracks located in the test section.

Photo 7 shows a view of a typical section of roadway located in the control section where no silane was applied. It appears from photos 6 and 7 that the staining effect is not as apparent in the silane section. Notice in photo 7 the stained areas that are evident near the edge of the roadway.

Photo 7. An overview of the control section.

Photo 8 shows a close-up of one of these areas located in the control section. The staining effect seen in photo 8 encompasses several microcracks between the two major cracks.

At this point in the evaluation period, the silane section appears to be performing slightly better than the control section in slowing the progression of the "D" cracking.

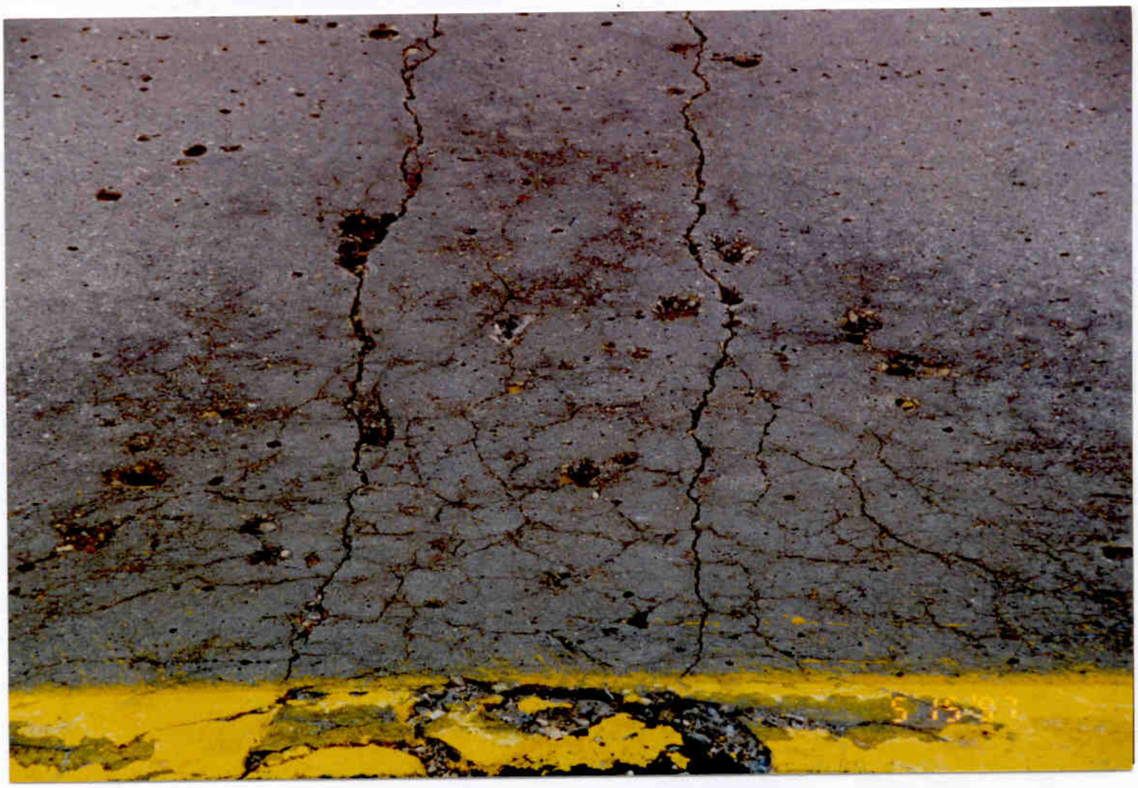


Photo 8. Close-up view of a distressed area near the edge line in the control section.

Eastbound 4" HBP Overlay (Section 2b)

Photo 9 depicts a typical crack in this test section. Total full length transverse cracks registered in a 1500' stretch of roadway is approximately 140. Most of the crack widths appear closer together than the westbound 4" section. There does not appear to be any noticeable rutting.

Photo 9. A view of a typical crack in the 4" overlay test section (EB).

Summary

It appears that the amount of full length transverse cracks found in the various HBP overlay test sections decreases as the thicknesses increase. Most of the cracks appeared tight in the HBP test sections, however, some cracks appeared slightly wider in one of the 4" test sections.

Table 7 tabulates the relation of overlay thickness and full length transverse cracks per 1500 ft.

Direction of Roadway	Overlay Thickness (in)	Full Length Transverse Cracks/1500 ft.
Eastbound	4.0	140
Westbound	2.0	227
Westbound	2.5	185
Westbound	3.0	169
Westbound	4.0	90

Table 7

The silane sections appear to be experiencing less staining around the cracks and joints as compared to the corresponding control section.

Recommendations

Efforts to control the progression of "D" cracking should start in the early stages of development. Any effort to restrict the amount of moisture entering the roadway from the top has limited benefits especially since "D" cracking tends to progress from the bottom of the slab upward.

Methods such as hot bituminous overlays(depending on the thickness) and applications of silane may slow the effects of "D" cracking simply because less water is allowed to enter the top of the roadway. The methods previously mentioned have no control of the moisture that may enter the slab from the bottom or sides.

The use of silane may have some effect in the early stages of "D" cracking. This is based solely on the decrease in staining seen as compared to surfaces that have no silane application. The fact that the use of silane may only slow the effects of "D" cracking only prolongs the inevitability of reconstruction or rehabilitation. The westbound silane test section and the corresponding control section received an asphalt overlay in July of 1997 immediately after the final evaluation.

The use of hot bituminous pavement as solely a retardant for the progression of "D" cracking is also questionable. One benefit of an asphalt overlay, however, is the structural component. If a substantial thickness of hot bituminous pavement is applied in the early stages of "D" cracking the traffic loads will not be as critical on the underlying slab itself. The overlying asphalt material would tend to spread out loads by the time they reach the CRCP slab. This reduction of pressure may aid in reducing the kind of distresses associated with "D" cracking. A thicker section, based on our evaluation, would tend to experience less transverse cracking also.

In conclusion, it is recommended that hot bituminous pavement be used to give structural integrity to a CRCP that is in the early stages of "D" cracking as well as seal the top surface of the slab from the effects of moisture. It is also recommended that the North Dakota Department of Transportation continue to monitor the performance of the varying HBP thicknesses and compare them to each other.

The use of silane as a retardant in the progression of "D" cracking is questionable and is not recommended.

Appendix A

JOB# 17

FHWA REGION	STATE	PROJECT	SHEET NO.
8	N.D.	IM-094-6(064)193	1

DESIGN DATA

Traffic		Average Daily				Est. 30th Max. Hr.
Current (1991)	3500 Pass.	900	Trucks	4400	Total	720
Forecast (2001)	5250 Pass.	1350	Trucks	6600	Total	1000

Design Speed 70 MPH
Traffic Classification "M"
Minimum Sight Distance (Stopping) 600'
Full control of access
No point of access other than by ramps at interchanges

NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

Federal Aid Project IM-094-6(064)193
in
Kidder County
Hot Bituminous Overlay
and Incidentals
(Both Roadways)

GOVERNING SPECIFICATIONS:

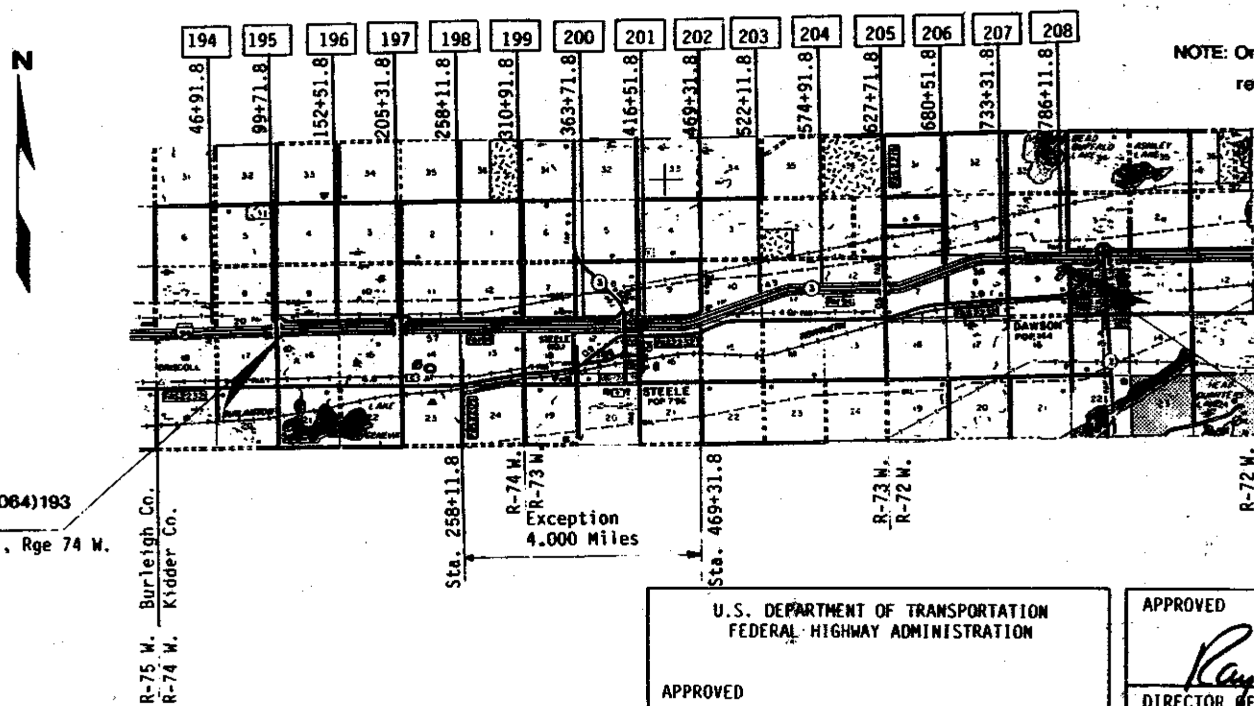
Standard Specifications for Road and Bridge Construction, adopted by the North Dakota State Highway Department, November 1986, shall apply to all North Dakota Department of Transportation contracts, standard drawings currently in effect, and other contract provisions submitted herein.

LENGTH OF PROJECT

Project	Miles-Gross	Miles-Net
IM-094-6(064)193	12.811	8.811

4.000 Miles Deducted for Exception

NOTE: Only the Title Sheet has been changed to reflect the new project number prefix.



T-140 N.
T-139 N.

Beg Project IM-094-6(064)193
Sta. 109+71.8
Sec. 16, Twp. 139 N., Rge 74 W.

End Project IM-094-6(064)193
Sta. 786+11.8
Sec. 9, Twp. 139 N., Rge. 72 W.

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED

DIVISION ADMINISTRATOR DATE

APPROVED DATE 9-...

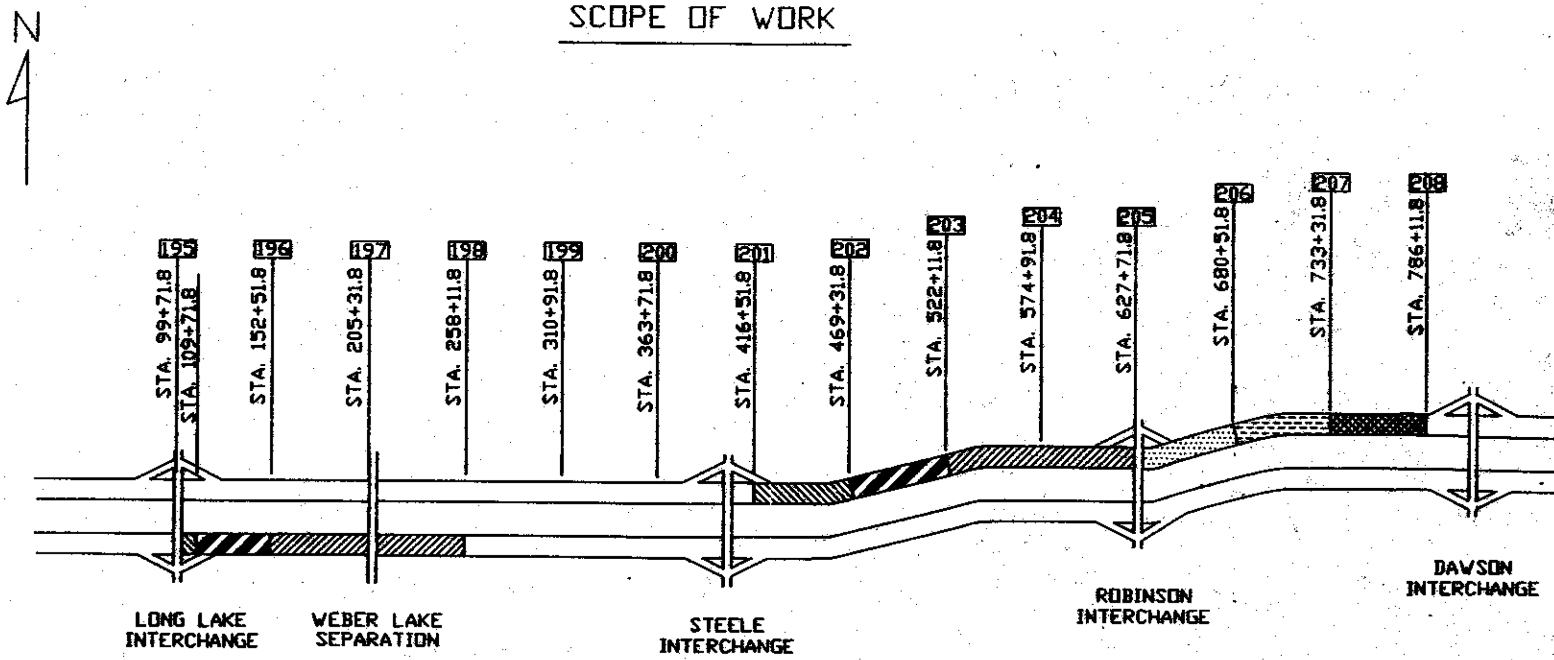
Ray Zink

DIRECTOR OF HIGHWAYS
AND ENGINEERING
NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

RAY ZINK
REGISTERED
PROFESSIONAL
P.E. 572
ENGINEER
NORTH DAKOTA

FHWA REGION	STATE	FED. AID PROJ. NO.	SHEET NO.
8	N.D.	IR-094-6(064)193	3

SCOPE OF WORK



LEGEND

- CONTROL SECTION
- SECTION 1 (SILANE SURFACE TREATMENT)
- SECTION 2 (4" OVERLAY)
- SECTION 3 (3" OVERLAY)
- SECTION 4 (2.5" OVERLAY)
- SECTION 5 (2" OVERLAY)

Table II: Aggregates for Asphalt Mixes, Blotter, and Seal Coats

Sieve Size Percent Passing	Asphalt Hot Mix Low to High Quality					Chip Seal	Chip Seal	Blotter Sand	Sand Seal
	25	27	29	31	33	42	43	44	45
3"									
1-1/2"									
1-1/4"									
1"									
3/4"									
5/8"	100	100	100	100	100			100	
1/2"	70–100	70–100	70–100	70–100	70–100				
3/8"						100	100		100
No. 4	40–70	40–70	40–70	40–70	40–70	20–70	20–70	90–100	85–100
No. 8	33–55	33–55	33–55	33–55	33–55	2–20	0–17		
No. 16	25–45	25–45	25–45	25–45	25–45				45–80
No. 30	15–35	15–35	15–35	15–35	15–35				
No. 50	10–30	10–30	10–30	10–30	10–30				10–30
No. 200	2.0–9.0	2.0–9.0	2.0–9.0	2.0–9.0	2.0–9.0	0–5	0–2	0–20	0–3
Shale[1]	8 [redacted]%	5%	5%	5%	5%	8%	8%		3%
L. A. Abrasion[1]	40%	40%	40%	40%	40%	40%	40%		
Plasticity Index[2]	0–3	0–3	0–3	N.P.	N.P.				
Fractured Faces[3]	35%	50%	50%	95%	95%				
Crushed Fines[4]			50%	65%	80%				

Footnotes for Tables I and II:

[1] Maximum Allowable Percentages.

[2] Maximum allowable unless range shown. N.P. = Non Plastic as per AASHTO T-90. Use material passing the No. 40 sieve (standard method). For Class 5 aggregate the maximum allowable Plasticity Index shall be determined from the following formula: Max. allowable PI for Class 5 = 10 - (% Passing No. 40 Sieve / 10)

[3] Minimum weight percentage allowable for the portion of the aggregate retained on a No. 4 sieve having at least 1 fractured face for Classes 4, 5, 13, 31, and 33, and at least 2 fractured faces for Classes 7, 25, 27 and 29.

[4] Minimum percentage of material passing a No. 4 sieve that is composed of fractured material produced by a crushing process. The Contractor shall demonstrate that the crushing operation produces this result.

Appendix B

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

SILANE SURFACE TREATMENT

PROJECT NO. IR-094-6(064)193

NOVEMBER 15, 1991

DESCRIPTION

This work shall consist of cleaning the concrete surface and applying a Silane sealant on the exposed concrete as specified.

MATERIALS

The concrete sealant shall be a 40 percent minimum, organosilane solution, diluted in a suitable solvent, and shall consist of alkyltrimethoxysilanes with alkyl groups of i-buryl, i-octyl, n-octyl, singularly or in combination.

The sealant shall be tinted with a fugitive dye which will cause the sealant to be distinguishable on the concrete surface for at least four hours after application, but shall disappear within seven days after application.

EQUIPMENT

The cleaning equipment used may be sandblasting, shotblasting, or high-pressure water washing equipment (7,000 psi minimum nozzle pressure). The equipment shall be capable of removing all dirt, debris, painted markings, and other deleterious materials including removal of existing laitance.

The sealant shall be applied with low pressure (15-30 psi) airless spray equipment fitted with fan spray nozzles. The sprayer shall be equipped with a positive metering system so the application rate can be verified during the operation and a calibrated pressure gauge showing the air pressure during the spraying operation. The sprayer shall be calibrated by the Contractor prior to beginning the project. Records shall be maintained and furnished to the Engineer to verify the accuracy of the sprayer.

CONSTRUCTION REQUIREMENTS

The Contractor shall arrange with the materials manufacturer to have a competent field representative at the work site prior to applying the sealant to instruct the work crews in the proper application procedure. The field representative shall remain at the job site and continue to instruct the work crews until the Engineer is satisfied that the Contractor can perform the work satisfactorily.

The concrete to be sealed shall be cleaned with equipment which removes all debris, painted markings, oil, grease, chemical films, and other deleterious material. After cleaning and immediately prior to sealing, the surface shall be air blown to remove all surface dust or dirt and loose surface material.

If the surface is wet, the concrete shall be allowed to dry fully (minimum 24 hours) prior to applying the sealant.

The sealant shall be applied in one coat with a coverage rate of 125 square feet per gallon. The sealant shall not be diluted in any way.

The sealant shall be applied only when the atmospheric temperature is between 40° and 100°F. The sealant shall not be applied when: (1) The temperatures are expected to fall below 40°F within 12 hours; or (2) if rain is expected within 4 hours following application; or (3) when wind or other conditions prevent proper application.

The Contractor shall uniformly dampen the treated concrete using a fine water spray after the Silane treated surface appears dry and not later than 24 hours after the surface appears dry.

Traffic shall not be allowed on the treated surface until the post wetted surface has dried.

MEASUREMENT AND PAYMENT

"Silane Surface Treatment" shall be measured and paid for by the square yard of pavement treated.

The contract unit price paid per square yard of Silane Surface Treatment shall include full compensation for all labor (including the manufacturer's field representative), materials, and equipment required to complete the work.